

SIMULATION OF FUZZY LOGIC FOR WATERING PLANT USING
SPRINKLER

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ABSTRACT

Project of simulation of fuzzy logic for watering plant using sprinkler is about simulate the total water that sprinkler needs to spray to the plants based on the inputs of the project. The inputs of the project are weather temperature and soil moisture temperature. This project is developed because to help the farmers to control the total of water for watering their plants. This system is suitable for users who use the sprinkler to watering their plants like farmers. The project actually created for Kuantan Department of Agriculture, Pahang to help them to control the total water of watering the plant. The system can use when user inserts the value of input; weather temperature and soil moisture temperature. After that, the total of water that watering plant will be calculated when the user clicks the calculate button. Then, user needs to click's simulation button to see the simulation of this project. From the system, hopefully can help the farmers and the other user to use this system to control their total of water of watering plant.

ABSTRAK

Projek simulasi fuzzy logic untuk menyiram tanaman menggunakan pemercik tanaman tentang simulasi jumlah air yang diperlukan untuk disembur oleh pemercik untuk menyiram tanaman berdasarkan input projek. Projek ini dibangunkan untuk membantu para petani untuk mengawal jumlah air untuk menyiram tanaman mereka. Sistem ini sesuai bagi pengguna yang menggunakan pemercik untuk menyiram tanaman merka seperti petani. Projek ini sebenarnya dicipta kepada Jabatan Pertanian Kuantan, Pahang untuk membantu mereka mengawal air untuk penyiraman tanaman. Sistem ini boleh digunakan apabila pengguna memasukkan nilai input iaitu suhu cuaca dan suhu kelembapan tanah. Selepas itu, jumlah air untuk menyiram tanaman akan dikira apabila pengguna klik pada butang kiraan. Kemudian, pengguna perlu klik pada butang simulasi untuk melihat simulasi projek ini. Dari sistem ini, diharapkan dapat membantu para petani dan pengguna lain untuk mengguna sistem ini untuk mengawal jumlah air untuk menyiram tanaman.

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CHAPTER 1

INTRODUCTION

This chapter briefly discusses on the overview of this research. It contains five sections. The first sections are introduction then follow by the problem statements. Next are the objectives where the project's goal is determined. After those are the scopes of the system and lastly is the thesis organization which briefly describes the structure of this thesis.

1.1. Background

Simulation is the process of imitating a real phenomenon with a set of mathematical formulas. Advanced computers programs can simulate weather conditions, chemical reactions, atomic reactions, even biological processes.

Fuzzy logic is not logic that is fuzzy, but logic that is used to describe fuzziness. Fuzzy logic is that theory of fuzzy sets, sets that calibrate vagueness. Fuzzy logic is based upon the idea that all things admit of degrees of temperature, height, speed, distance, and beauty.

Simulation of fuzzy logic for watering plant using sprinkler is the form of computer based simulated environment through which user can control their watering plant from waste the water for their plants. Besides that, they do not have to about their fertility.

By developing this can be improved the system, that earlier have. From the system that earlier has, we know that sprinkler only can set their time for ejection; it is

automatic splash when we set their time. From developing new system, we can save water for wasting. This system wills automatic watering the plants depend of weathers and soil moisture. If the weather that day was heavy rain, the system will not be watering plants and vice versa.

1.2. Problem Statement

In a current practice, watering sprinkler that uses in watering plant is a manual way. People need set up timer for sprinkler spray water for watering. There are few problems that need to be concern. One of the problems is when the hot days; plants need more water and sprinkler only watering the plant at the time set. This cause's plant growth is retarded, and some survive for long time.

The other problem is when the rainy day; the sprinkler still watering the plant at the time is set-up is usually two times a day; morning and evening. This cause of water wastage occurs, and the plants damaged due to excessive water.

1.3. Objective

The objectives of the project are:

- i. To develop a prototype to simulate a sprinkler.
- ii. Apply fuzzy logic technique to the simulation.

1.4. Scope

The scope for the project is:

- i. The system is developed for reduce wastage of water and control the spraying time.
- ii. The target user for this system is farmers.
- iii. Input of watering sprinkler are weather temperature and soil moisture temperature.

- iv. Output for watering sprinkler is total water that spray by sprinkler.
- v. The device will be used to run the system is Visual Studio 2008.

1.5. Thesis Organization

This thesis consists of four (4) chapters. Chapter one (1) is Introduction. Explanation of introduction into the system. In this chapter, system overview, problem statements, objectives and scope to the project is discussed.

Chapter two (2) is Literature Review that will discuss more on the research for the project that has been chosen. The research is divided into two, that is current system or case study and research for technique that will be used to develop the current system.

In Chapter three (3) is Methodology of overall work load to develop this system will be discuss. The content consists of the approach and framework for the project that used for the system also the implementation of the process that is involved during development of this system.

Lastly, in chapter four (4) is the Conclusion. In this chapter, briefly summarize all the chapters involve and the results or outputs that obtained from the implementation of the system are discussed thoroughly. The constraints of this project are also stated clearly.

CHAPTER 2

LITERATURE REVIEW

This chapter is to explain about reviews for this project. It is divided to two major parts: system/present review and technique, method, equipment, as well technology review.

2.1. Current Practice Review

An interview has been conducted with Mr. Azmi bin Abd. Aziz, Assistant of Agriculture Department Kuantan, Pahang. There are several types of plants that have different quantity of water was needed water normally used for crops was excavated from the pond. Agriculture department has planted a crop that uses water as a way to splash the plants. Cucumber crops is an area is 6x10 meters. Cost of water for the crops is in the estimated RM300 per month. It used to sprinkler the cucumber plants should be set twice a day, morning and evening. Crops generally use a sprinkler is all kinds of plants except for fruit. Fruit normally drops way. Waste water will be sprayed during the day when the sprinkler was raining. Amount of sprinkler water spray is the same every day. Methods to reduce wastage of water that Agriculture Departments are using the droplet. The method is not very helpful because only certain crops can use the method.

2.2. Existing Systems Review

This section is reviewed the current system and the existing system that related to simulation of fuzzy logic for watering plant using sprinkler.

2.2.1. Garden Water Dispersal Controller

Sprinklers are used on farms, golf courses, and yards, to provide water to vegetation and plants in the event of drought. They may also be used for recreation, as a cooling system, or to keep down the amount of airborne dust. There have 4 types of sprinkler; Industrial, Residential sprinklers, Underground sprinklers and Farm sprinklers. Most sprinklers are used as part of a sprinkler system, consisting of various plumbing parts, piping and control equipment. Piping is connected to the water source via plumbing fittings and the control system opens and closes valves to provide water on a schedule. The control provided varies depending on the equipment used; some systems are fully automated and even compensate for rain, runoff and evaporation, while others require much more user attention for the same effectiveness. [1]

One of the most important elements in lawn maintenance is the moisture adequacy. For this reason, irrigation, done by manual or automated sprinkler system, has been applied.

However, both systems may use excessive amount of water and the amount dispersed may not be suitable for the moisture level of the lawn. Therefore, there is a need to develop an irrigation system that can measure and monitor the soil moisture through data acquired from the soil and also from the climatologic factors that will help to decide when to water and how much water is needed. Once the actual rules and fuzzy sets are determined, the comparison of the conventional irrigation system with all four fuzzy inference methods was conducted with each other. The intention is to see which system is better in optimizing water usage. Lastly, a simulation system was built to demonstrate the soil moisture content of the lawn, the percentage pattern of soil moisture and daily data involved in the system. [2]

Created with

2.2.2. Air-conditioning System

The fuzzy controlled of automobile air-conditioner was designed to establish fuzzy membership, fuzzy output and translated fuzzy outputs to precise value. The simulation frame of automobile air-conditioner compartment temperature was built to simulated which under summer environment and the temperature automobile can be controlled in the expected scope. [1]

The Fuzzy logic system is used to design this algorithm. Two inputs and one output are designed with an industrial application in mind. This system consists of two sensors for feedback control: one to the monitor of temperature and another one to the monitor of humidity. There are three control elements: cooling valve, heating valve, and humidifying valve, to adjust the temperature and humidity of the air supply. Fuzzy rules are formulated by temperature and humidity. The model of this controller algorithm has been simulated using MATLAB simulation. [3]

Temperature control in an automobile passenger environment is more complex than that of a static room in a building. With regards to both driver and passenger comfort and safety, a lot of factors must be taken in account. Therefore, the objective of this paper is to study the implementation of fuzzy logic control in automobile climate control system compared to the existing state flow controller. [4]

2.2.3. Controller for HVAC Systems

HVAC (Heating, Ventilating and Air Conditioning) systems controller which employs a control algorithm using these either fuzzy logic reasoning or rough set theory. The controller deduces the appropriate control outputs from sensor readings. The system is capable of controlling temperature and humidity. To maintain temperature at the reference point, the controller adjusts the flow of hot water in a heating coil for heating operation or the flow of chilled air through the air duct for cooling operation.

To control humidity, the controller turns on and off a humidifier. The fuzzy logic reasoning shows better performance in both temperature and humidity control than the rough set method. In particular, for humidity control, the method of fuzzy logic reasoning shows better performance than the rough set method. [5]

This system has been embedded in microprocessors with interfaces to the sensors, compressor, and air circulation fan and installed in a test building for performance evaluation. Some results of the analysis and performance evaluation for the fuzzy logic control system are presented as well as a discussion of the performance of the system from a subjective point of view of humans living in the facility. [6]

2.2.4. Water Level Control

Synthesis water level control by fuzzy logic focuses on evolving of two type's fuzzy and classical Proportional, Integral and Derivative(PID) liquid level controller and examining whether they are better able to handle modeling uncertainties. A two stage strategy is employed to design the synthesis fuzzy and classical PID controller with the process of the first and second order and implement s disorder (quadratic function). Fuzzy controller allows the user apply their knowledge of the problem and transfer it to an appropriate system environment, which is close to the human way of thinking (liquid level tank control). Because this is a more complex task than just inserting a few control parameters we use a special user interface (FIS) for designing fuzzy logic applications. [7]

The fuzzy control system determines required water ratio precisely to regulate the temperature instead of using trials for adjusting the water ratio when applying conventional control. It is an important factor of the given control system eventually reaches an equilibrium state, after which the temperature barely needs to be adjusted anymore. A conventional control method causes the waste of hot or cold water, which means not optimal utilization of energy. [8]

The purpose of this project is to design a simulation system of fuzzy logic controller for water tank level control by using simulation package which is Fuzzy Logic Toolbox and Simulink.in MATLAB software. In order to find the best design to

stabilize the water level in the system, some factors will be considered. For this project, the water level was controlled by using three rules of membership function which then extended to five rules and seven rules for verification purpose and further improvement of the system. Besides that, several of different methods also been used in order to design the most stabilize system and this project was focused to the software part only. By doing some modification of this project, the design will be very useful for the system relates to liquid level control that widely use in industry nowadays. [9]

2.2.5. An Introduction to Fuzzy control System

A fuzzy control system is a control system based on fuzzy logic. Fuzzy logic is widely used in machine control. The term itself inspires a certain skepticism, sounding equivalent to "half-baked logic" or "bogus logic", but the "fuzzy" part does not refer to a lack of rig our in the method, rather to the fact that the logic involved can deal with fuzzy concepts—concepts that cannot be expressed as "true" or "false" but rather as "partially true". [10]

Fuzzy controllers are very simple conceptually. They consist of an input stage, a processing stage, and an output stage. The input stage maps sensor or other inputs, such as switches, thumbwheels, and so on, to the appropriate membership functions and truth values. The processing stage invokes each appropriate rule and generates a result for each, then combines the results of the rules. Finally, the output stage converts the combined result back into a specific control output value. The most common shape of membership functions is triangular, although trapezoids and bell curves are also used, but the shape is generally less important than the number of curves and their placement. From three to seven curves are generally appropriate to cover the required range of an input value, or the "universe of discourse" in fuzzy jargon. As discussed earlier, the processing stage is based on a collection of logic rules in the form of IF-THEN statements, where the IF part is called the "antecedent" and the THEN part is called the "consequent". Typical fuzzy control systems have dozens of rules. [11]

2.2.6. Traffic Light Controller

Traffic congestion is the main thing that worries people around the world. By developing a sophisticated traffic and more effective monitoring and control system that is effective, it can help solve this problem. In the conventional traffic light controller, traffic lights change at constant cycle time. It does not provide an optimal solution. Traffic light controller based on fuzzy logic can be used for optimal control of variable volume overload, such as the saturated conditions or unusual. Objective is to increase the vehicle throughput and minimize delays to the public. [12]

A fuzzy traffic lights controller to be used at a complex traffic junction in the middle of Kuala Lumpur city, Malaysia was proposed. The proposed fuzzy traffic lights controller is capable of communicating with neighbor junctions and manages phase sequences and phase lengths adaptively. A real case study of a complex traffic junction is simulated having 4 intersections. Average flow density, average delay time and link overflow of all the 4 intersections are used as performance indices when comparing the fuzzy controller with two other existing traffic lights controllers in Malaysia, namely the preset cycle time and vehicle-actuated controllers. A simulator has been developed to show the effectiveness of the fuzzy traffic controller which can also be used for teaching purposes. [13]

When the numbers of road user constantly increase, and resources provided by current infrastructures are limited, intelligent control of traffic will become a very important issue in the future. However, some limitations to the usage of intelligent traffic control exist to avoiding traffic jams. Three series of experiments was performing with using the green light district traffic simulator. The first experiment, which uses a large grid, shows that reinforcement learning is efficient in controlling traffic. The second experiment shows that using co-learning vehicles avoid crowded intersections. The third experiment shows that RL algorithms on more complex and city-like infrastructure again outperform the fixed controllers by reducing waiting time with more than 25%. [14]

2.2.7. How Irrigation Works

Water is essential to plants. It carries important nutrients from the soil and is an important trigger for germination and the process of photosynthesis. Without water, plants simply won't grow. Irrigation systems provide water. When it comes to watering plants in our yards or gardens, most of us don't always like to rely on the weather -- we may use watering cans or sprinkler systems. This is irrigation at its simplest level. [15]

Many drip irrigation management schemes rely on frequent monitoring of soil water content and matric potential using various sensors. The information is used either for scheduling irrigation, or for adjusting schedules based on evapotranspiration measurements. Most soils exhibit spatial variations in their hydraulic properties, which in turn, induce spatial variations in wetting patterns about the drippers. The objective of this study was to quantify effects of mild spatial variation in soil hydraulic properties on the mean and variance of soil water content and matric potential distribution about point sources and the consequences on soil water sensor placement and interpretation. [16]

The system can call a preset number at a set time with a message that irrigation is proceeding as scheduled. The system significantly reduces human labor. It is automatic. Human inputs are required only as crop water needs change. Growers will use automotive resource management to remain competitive, reduce labor and meet environmental requirements. [17]

2.3. Tool and Equipment

2.3.1. MATLAB/Simulink tool

Most of the existing systems use the MATLAB/Simulink tool to design the prototype system. The existing systems are Automobile Air-conditioner, Traffic Light Controller, Water Level Control, Intelligent Traffic Light Control, Control the Extension Time of Traffic Light in Single Junction, Air-conditioning System, Control for Non Linear Car Air Conditioning, and Water Tank Level Control.

By using MATLAB/Simulink, Fuzzy Logic Toolbox packages and MATLAB programming for stabilizing the water tank level control, it is a simple and easy approach to know more about water level system, including its level movements, valve setting, data consistency, and also about the rules of the variables. [15]

A prototype system for controlling traffic at an intersection is designed using VB6 and Matlab tool. The traffic intersection is simulated in VB6 and the data regarding the traffic parameters is collected in VB6 environment. The decision on the duration of the extension is taken using the Matlab tool. This decision is based on the Arrival and Queue of vehicles, which is imported in Matlab from VB6 environment. The time delay experienced by the vehicles using the fixed as well as fuzzy traffic controller is then compared to observe the effectiveness of the fuzzy traffic controller. [2]

2.3.2. Visual Basic 6 (VB6) environment

Function of visual basic 6 (VB6) is same with Matlab tool; it is to design the prototype system. Typically, designer uses the Matlab tools to design their prototypes than VB6 because Matlab tools easier to use.

A prototype system for controlling traffic at an intersection is designed using VB6 and Matlab tool. The traffic intersection is simulated in VB6 and the data regarding the traffic parameters is collected in VB6 environment. The decision on the duration of the extension is taken using the Matlab tool. This decision is based on the Arrival and Queue of vehicles, which is imported in Matlab from VB6 environment. The time delay experienced by the vehicles using the fixed as well as fuzzy traffic controller is then compared to observe the effectiveness of the fuzzy traffic controller. [2]

2.4. Techniques

2.4.1. Fuzzy Logic

2.4.1.1. Fuzzy Set

The concept of a set is fundamental to mathematics. However, our own language is also the supreme expression of sets.

The simulation will display the animation of the water tank level that controlled based on the rules of fuzzy sets. This project covers the processes of developing the application of fuzzy expert system in water tank level control. It starts from the theory until it implemented into the simulation environment. [15]

2.4.1.2. Linguistic Variable and Hedges

At the root of fuzzy set theory lies the idea of linguistic variables. A linguistic variable is a fuzzy variable. For example, the statement “John is tall” implies that the linguistic variable *John* takes the linguistic value *tall*.

The linguistic description of expert can be set as rules (IF...THEN). These rules of control system can be written as following:

IF the temperature is mild and the change of temperature is zero THEN the conditioning system must be stopped.

IF the temperature is mild and the change of temperature is big positive THEN the cold water streaming must be increased (Normal Cooling).

IF the temperature is cold and the change of temperature is zero THEN the hot water streaming must be increased (Normal Heating).

The other rules can be written in the same manner. [8]

2.4.1.3. Fuzzy Rule

A fuzzy rule can be defined as a conditional statement in the form:

IF x is A

THEN y is B

Where x and y are linguistic variables; and A and B are linguistic values determined by fuzzy sets on the universe of discourses X and Y , respectively.

After a minimum green (5 s)

If Arrival is few AND Queue is (few OR small OR medium OR many) then Extension is zero.

Else if Arrival is small AND Queue is (few OR small) then

Extension is short.

Else if Arrival is small AND Queue is (medium OR many) then Extension is zero.

Else if Arrival is medium AND Queue is (few OR small) then Extension is medium.

Else if Arrival is medium AND Queue is (medium OR many) then Extension is short.

Else if Arrival is many AND Queue is few then Extension is long.

Else if Arrival is many AND Queue is (small OR medium) then Extension is medium.

Else if Arrival is few AND Queue is many then Extension is short. [2]

Beside that fuzzy rule also in the table such as in existing system:

Table 2. GreenPhase Module Fuzzy Rules.

RULE	INPUTS		OUTPUTS
	QueueNum	FrontNum	Extend
1.	Z		Z
2.	S	S	S
3.	S	M	S
4.	S	L	S
5.	M	S	L
6.	M	M	M
7.	M	L	S
8.	L	S	VL
9.	L	M	VL
10.	L	L	L

This is example of fuzzy rule base table. [3]

2.5. Summary

From this chapter is to discuss the existing system and discuss the tools and techniques used in existing systems. From the existing system of fuzzy logic related control and simulation, we can concluded that apply the systems from the real system into simulation system using a fuzzy expert system. To generate the real system, it requires high cost and long time.

CHAPTER 3

METHODOLOGY

In this chapter will discuss about the methodology that will be using in the development of Simulation of Fuzzy Logic for Watering Plant using Sprinkler. For Simulation of Fuzzy Logic for Watering Plant using Sprinkler, the **Rapid Application Development (RAD) method** was choosing because RAD has several characteristic that is suitable for the development of Simulation of Fuzzy Logic for Watering Plant using Sprinkler. There have three section consists in this chapter. The first section explains about the introduction of the RAD development method and the reason to choosing the RAD approach. The next section discuss about the implementation of RAD method in Simulation of Fuzzy Logic for Watering Plant using Sprinkler development. The last section will elaborate the hardware and software that was used in the development of Simulation of Fuzzy Logic for Watering Plant using Sprinkler.

3.1 Rapid Application Development (RAD)

Methodology of the project to develop this fuzzy logic system is Rapid Application Development model (RAD). RAD is a software development methodology that uses minimal planning in favour of rapid prototyping. The planning of software developed using RAD is interleaved with writing the software itself. The lack of extensive pre-planning generally allows software to be written much faster, and makes it easier to change requirements. In rapid application development, structured techniques and prototyping are especially used to define users' requirements and to design the final system. The development process starts with the development of preliminary data models and business process models using structured techniques. In